6. 論文で見る附属天文台の研究成果

6.1 附属天文台の代表的論文の抄録

宮本正太郎博士の代表的論文4編以外は、被引用数上位25位までの代表的論文(1980年以後出版)。

Vol. 1, Nos. 1–2. Publications of the Astronomical Society of Japan. 1949

Ionization Theory of Solar Corona.*

Shotaro MIYAMOTO.
Institute of Astrophysics, Kyoto University.
(Received November 1, 1948.)

Abstract.

The theory of ionization in the corona is treated. The equilibrium of ionization in the corona is kept by the photoelectric recombination vrs. collisional ionization, if we assume the radiation temperature 6000, and a high electron temperature, as is suggested from the line widths and the continuous spectra. A new type of ionization formula is obtained and discussed in comparison with observations. Fe-ionization is treated in detail. The theory requires an electron temperature of the order 10^6 to account for the observed stage of ionization.

*) *Contributions from the Institute of Astrophysics, Kyoto University, No. 1.* Translated from *Tenmon-Uchû-Butsurigaku Iho* (*Acta Astronomica Cosmophysicaque*) **2**, 29 (1943) published in Japanese.

(解説) コロナの温度が100～200万度であることを世界で最初に正確に示した論文。

S. MIYAMOTO

Contributions from the Institute of Astrophysics and
Kwasan Observatory, University of Kyoto. No. 71.

The Great Yellow Cloud and the Atmosphere of Mars. Report of Visual Observations during the 1956 Opposition.

By S. Miyamoto,

(*Received 11 March 1957*)

ABSTRACT

Part I. General description of the surface markings during the 1956 opposition before the appearance of the great yellow cloud. Emergence of the cloud, its developement and the disappearance have been described.

Part II. The motion of the cloud was assumed geostrophic, and derived the pressure distribution in the southern summer. The south polar region was occupied with the anticyclone. The thermal equator was the belt of anticyclone. The centers of anticyclone were located over Syrtis Major, Mare Cimmerium and Margaritifer Sinus, and inter-anticyclone areas between them : Solis Lacus–Mare Sirenum and Sinus Sabaeus–Mare Serpentis. The belt of temperate zone was identified with the cyclonic zone. The pressure difference between anticyclone and cyclone was estimated from the wind velocity as about 2 mb.

The great yellow cloud turned round the south pole along the temperate zone in the westward direction within 16 days. This suggests that the wind in the lower Martian atmosphere is dominated by the easterlies contrary to the case of our globe. A brief comparison was given between Mars and our planet.

Part III. A characteristic feature of the Martian atmosphere is the smallness of its water vapour content. Under the normal condition, the water vapour is insufficient to warm up the air by the absorption of long wave radiations. The emergence of the great yellow cloud was attributed to the rapid increase of water vapour supplied through the channel of Hellespontus from the south polar cap at the time of spring thawing. The increase of water vapour might have warmed up the air over the hottest region, Mare Serpentis-Noachis, and it subsequently gave rise a strong vertical convection and the cloud formation.

Part IV. List of observational data and drawings.

（解説）火星の大黄雲の動きから偏東風を発見した論文。

ICARUS 3, 486-490 (1964)

Morphological Aspects of the Lunar Crust

S. MIYAMOTO

Kwasan Observatory, University of Kyoto, Kyoto, Japan

Communicated by A. G. Wilson

Received October 9, 1964

The most important factors for the interpretation of the lunar surface features are viscosity of original magma and thickness of the original crust. Morphological features first revealed by the US Moon rocket Ranger VII suggest that the original magma in Mare Nubium is basic and characterized by its rich gas content, and that the magmatic differentiation took place at the time of crustal formation, and craters and other surface features were molded by processes quiet and not catastrophic in nature. Morphological characteristics directly corresponding to petrological properties of magma are considered in some detail for large-scale tectonics.

（解説）宮本博士による月観測の代表的論文。

ICARUS 5, 360-374 (1966)

Martian Atmosphere and Crust

S. MIYAMOTO

Kwasan Observatory, University of Kyoto, Kyoto, Japan

Received November 9, 1965

The Martian atmosphere in its average condition is inactive and transparent to long-wave radiation. It is activated when moisture is supplied by the evaporation of the polar cap in spring time. As typical examples, the great yellow cloud in 1956, the Neith-Casius cloud, and the Propontis cloud are described.

It is shown that we can derive some knowledge about surface relief indirectly from cloud observations.

In the Martian summer, energy flows from the summer hemisphere to the winter hemisphere and the prevailing wind over middle latitudes turns from spring westerlies to summer easterlies. This prediction has been confirmed through the following observations: a springtime polar front and associated dark fringe, some peculiar behavior of the polar cap shrinking, and the summertime diagonal cloud layers.

A tentative picture of the circulation pattern in the northern hemisphere is proposed on the basis of our cloud data.

Crater morphology revealed by the Mariner IV photographs suggests that craters are one of the characteristic features of the original crust of terrestrial-type planets and that Martian deserts and maria correspond to the terra and maria of the Moon and the continents and oceans of our Earth, respectively.

Canals are interpreted as tectonic lines. It may be shown how wind erosion destroys most of the tectonic lines but develops some of them into canals when they are properly located along the courses of vapor migration.

（解説）宮本博士による火星観測の代表的論文。

THE ASTROPHYSICAL JOURNAL, 545:524–531, 2000 December 10

AN EMERGING FLUX TRIGGER MECHANISM FOR CORONAL MASS EJECTIONS

P. F. CHEN[1,2] AND K. SHIBATA[1]

Received 2000 May 12; accepted 2000 July 24

ABSTRACT

Observations indicate that reconnection-favored emerging flux has a strong correlation with coronal mass ejectons (CMEs). Motivated by this observed correlation and based on the flux rope model, an emerging flux trigger mechanism is proposed for the onset of CMEs, using two-dimensional magnetohydrodynamic (MHD) numerical simulations: when such emerging flux emerges within the filament channel, it cancels the magnetic field below the flux rope, leading to the rise of the flux rope (owing to loss of equilibrium) and the formation of a current sheet below it. Similar global restructuring and a resulting rise motion of the flux rope occur also when reconnection-favored emerging flux appears on the outer edge of the filament channel. In either case, fast magnetic reconnection in the current sheet below the flux rope induces fast ejection of the flux rope (i.e., CME). It is also shown that the nonreconnecting emerging flux, either within the filament channel or on the outer edge of the channel, makes the flux rope move down, i.e., no CMEs can be triggered. Although the present two-dimensional model can not provide many details of the largely unknown three-dimensional processes associated with prominence eruptions, it shows some observational features such as the height-time profile of erupting prominences. Most importantly, our model can well explain the observed correlation between CMEs and the reconnection-favored emerging flux.

Subject headings: Sun: corona — Sun: flares — magnetic fields — MHD

（解説）花山・飛騨天文台関係者論文の被引用数ベスト 25 でトップ（引用数 108）の論文。

Solar Physics **93** (1984) 105–121.

Hα RED ASYMMETRY OF SOLAR FLARES*

K. ICHIMOTO and H. KUROKAWA

Kwasan and Hida Observatories, University of Kyoto, Kamitakara, Gifu, 506-13, Japan

(Received 12 December, 1983; in revised form 30 March, 1984)

Abstract. The evolutional characteristics of the red asymmetry of Hα flare line profiles were studied by means of a quantitative analysis of Hα flare spectra obtained with the Domeless Solar Telescope at Hida Observatory. Red-shifted emission streaks of Hα line are found at the initial phase of almost all flares which occur near the disk center, and are considered to be substantial features of the red asymmetry. It is found that a downward motion in the flare chromospheric region is the cause of the red-shifted emission streak. The downward motion abruptly increases at the onset of a flare, attains its maximum velocity of about 40 to 100 km s^{-1} shortly before the impulsive peak of the microwave burst, and rapidly decreases before the intensity of Hα line reaches its maximum. Referring to the numerical simulations made by Livshits *et al.* (1981) and Somov *et al.* (1982), we conclude that the conspicuous red-asymmetry or the red-shifted emission streak of Hα line is due to the downward motion of the compressed chromospheric flare region produced by the impulsive heating by energetic electron beam or thermal conduction.

（解説）「太陽フレアの写真分光観測の頂点をきわめた」（R. Canfield et al. 1990）と絶賛された歴史的論文。飛騨 DST 観測論文の中では最も被引用数が多い（引用数 96）。

***Nature*, 316,** 422. (1985)

Periodic behaviour of solar flare activity

K. Ichimoto, J. Kubota, M. Suzuki*, I. Tohmura & H. Kurokawa

Kwasan and Hida Observatories, University of Kyoto, Yamashina, Kyoto 607, Japan

The periodic nature of solar activity has been studied using parameters such as the sunspot Wolf numbers, calcium plage areas and flare indices. The magnitude of the solar activity based on these parameters reveals periodicities other than the most pronounced 11-yr one. Any absolute detection of periodicity in active phenomena would have fundamental significance for our understanding of solar activity. Here we investigate the temporal variation of the flare activity of the Sun using the data of 8,821 Hα flares which occurred during the period January 1965 to February 1984, and show new evidence for 155-day and 17-month periodicities of the flare activity. The 155-day periodicity is examined by taking into account the location of the flare on the Sun. It is suggested that the 155-day period may be related to the timescale for the storage and/or the escape of the magnetic field.

（解説）「フレア現象 155 日周期も」と新聞で大きく報道された。p. 56 の新聞記事参照。

Earth Planets Space, **53**, 473–482, 2001

Plasmoid-induced-reconnection and fractal reconnection

Kazunari Shibata[1] and Syuniti Tanuma[2]

[1]*Kwasan Observatory, Kyoto University, Yamashina, Kyoto 607-8471, Japan*
[2]*STE Laboratory, Nagoya University, Toyokawa, Aichi 442-8507, Japan*

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As a key to undertanding the basic mechanism for fast reconnection in solar flares, *plasmoid-induced-reconnection* and *fractal reconnection* are proposed and examined. We first briefly summarize recent solar observations that give us hints on the role of plasmoid (flux rope) ejections in flare energy release. We then discuss the plasmoid-induced-reconnection model, which is an extention of the classical two-ribbon-flare model which we refer to as the CSHKP model. An essential ingredient of the new model is the formation and ejection of a plasmoid which play an essential role in the storage of magnetic energy (by inhibiting reconnection) and the induction of a strong inflow into reconnection region. Using a simple analytical model, we show that the plasmoid ejection and acceleration are closely coupled with the reconnection process, leading to a *nonlinear instability* for the whole dynamics that determines the macroscopic reconnection rate uniquely. Next we show that the current sheet tends to have a *fractal structure* via the following process path: tearing ⇒ sheet thinning ⇒ Sweet-Parker sheet ⇒ secondary tearing ⇒ further sheet thinning ⇒ ···. These processes occur repeatedly at smaller scales until a microscopic plasma scale (either the ion Larmor radius or the ion inertial length) is reached where anomalous resistivity or collisionless reconnection can occur. The current sheet eventually has a fractal structure with many plasmoids (magnetic islands) of different sizes. When these plasmoids are ejected out of the current sheets, fast reconnection occurs at various different scales in a highly time dependent manner. Finally, a scenario is presented for fast reconnection in the solar corona on the basis of above *plasmoid-induced-reconnection in a fractal current sheet*.

Solar Physics **113** (1987) 259–265.

TWO DISTINCT MORPHOLOGICAL TYPES OF MAGNETIC SHEAR DEVELOPMENT AND THEIR RELATION TO FLARES

H. KUROKAWA
Kwasan and Hida Observatories, University of Kyoto,
Kamitakara, Gifu Prefecture 506-13, Japan

ABSTRACT. From a morphological study of the evolution of six active regions, we found two types of processes for the development of magnetic shear configurations between sunspots: (A) collision of two sunspots of opposite magnetic polarities, and (B) successive emergence of twisted magnetic flux ropes. We conclude that the process (B) might be essential for the production of major flares.

Solar Physics **65** (1980) 207–220.

MORPHOLOGICAL STUDY OF THE SOLAR GRANULATION

II. *The Fragmentation of Granules*

ICHIRO KAWAGUCHI

Department of Astronomy, Faculty of Science, University of Kyoto

(Received 12 July; in revised form 24 September, 1979)

Abstract. A time sequence of granulation images of 46 min long has allowed us to make a detailed study of the evolution of granules in an area of approximately $17'' \times 17''$ on the solar surface. It is found that the granules evolve by repeated fragmentation into smaller granules or merging with adjacent ones and that there are few granules which appear in the intergranular lanes as new granules (Table III). The statistical nature of granules is as follows:

(1) A family of granules is defined as a group of granules produced from a single granule by fragmentation or merging. The lifetime is estimated for single granules and for families of granules. The lifetime shows a close correlation with the maximum size of a single granule or with that of the largest granule belonging to a family (Figures 5 and 7).

(2) The smaller the size, the more probably a granule will disappear without further fragmentation or merging. The granule whose size is larger than 2" will certainly split or merge as the next evolutional step (Table IV).

THE ASTROPHYSICAL JOURNAL, 499:898–904, 1998 June 1

EMERGENCE OF A TWISTED MAGNETIC FLUX BUNDLE AS A SOURCE OF STRONG FLARE ACTIVITY

TAKAKO T. ISHII,[1,2] HIROKI KUROKAWA,[1] AND TSUTOMU T. TAKEUCHI[2,3]

Received 1997 August 20; accepted 1998 January 8

ABSTRACT

Sunspot proper motions and flares of a super active region NOAA 5395—the largest and most flare-active region in the 22d sunspot cycle—were analyzed in detail. We measured sunspot proper motions by using the Hα – 5.0 Å images obtained with the 60 cm Domeless Solar Telescope (DST) at Hida Observatory, Kyoto University and found some peculiar vortex-like motions of small satellite spots, which successively emerged from the leading edge of this sunspot group. To explain these motions of small sunspots, we proposed a schematic model of the successive emergence of twisted and winding magnetic flux loops coiling around a trunk of a magnetic flux tube. The location of the strongest flare activity was found to coincide with the site of the vortex-like motions of sunspots. We conclude that the flare-productive magnetic shear is produced by the emergence of the twisted magnetic flux bundle. Magnetic energy is stored in the twisted flux bundle, which is originally formed in the convection zone and released as flares in the course of the emergence of the twisted flux bundle above the photosphere.

Subject headings: MHD — Sun : activity — Sun : flares — Sun: magnetic fields — sunspots

Nature, **434,** 478 (2005)

letters to nature

Filamentary structure on the Sun from the magnetic Rayleigh–Taylor instability

Hiroaki Isobe[1], Takehiro Miyagoshi[1], Kazunari Shibata[1] & Takaaki Yokoyama[2]

[1]*Kwasan and Hida Observatories, Kyoto University, Yamashina, Kyoto 607-8471, Japan*
[2]*Department of Earth and Planetary Science, University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113-0033, Japan*

Magnetic flux emerges from the solar surface as dark filaments connecting small sunspots with opposite polarities[1–3]. The regions around the dark filaments are often bright in X-rays and are associated with jets[4–6]. This implies plasma heating and acceleration, which are important for coronal heating. Previous two-dimensional simulations of such regions showed that magnetic reconnection between the coronal magnetic field and the emerging flux produced X-ray jets and flares, but left unresolved the origin of filamentary structure and the intermittent nature of the heating. Here we report three-dimensional simulations of emerging flux showing that the filamentary structure arises spontaneously from the magnetic Rayleigh–Taylor instability[7,8], contrary to the previous view that the dark filaments are isolated bundles of magnetic field that rise from the photosphere carrying the dense gas[9–11]. As a result of the magnetic Rayleigh–Taylor instability, thin current sheets are formed in the emerging flux, and magnetic reconnection occurs between emerging flux and the pre-existing coronal field in a spatially intermittent way. This explains naturally the intermittent nature of coronal heating and the patchy brightenings in solar flares.

（解説）「太陽表面スパコンで再現」、「博士論文で新理論」などと多くの新聞で報道された。pp. 70–71 の新聞記事参照。

Solar Physics **87** (1983) 135–154.

ON THE MASS MOTIONS AND THE ATMOSPHERIC STATES OF MOUSTACHES

REIZABURO KITAI

Department of Astronomy, Faculty of Science, University of Kyoto, Kyoto 606, Japan

(Received 25 November, 1982)

Abstract. Analyses of broad moustache profiles of Balmer lines and Ca II H and K lines are performed based upon our spectroscopic observation under good seeing conditions. Hα emission profiles are found to consist of three components, i.e., a central absorption, a Gaussian core and a power-law wing. Each of them has a different Doppler shift from others. From the data of Doppler shifts, mass motions with velocity of about 6 km s^{-1} are found to be present in chromospheric levels of moustache atmospheres. Computations of Hα emission profiles radiated from a variety of model atmospheres are made. Comparison of computed profiles with the observed ones leads us to the conclusion that a broad Hα profile is due to a formation of heated (ΔT = 1500 K) and condensed (ρ/ρ_0 = 5) chromospheric layers relative to the normal.

（解説）moustaches とは Ellerman bombs の別名。p. 127 に Kurokawa et al.(1982, Solar Phys. 79, 77)で発表された Ellerman bombs の素晴らしいＨα写真が紹介されている。